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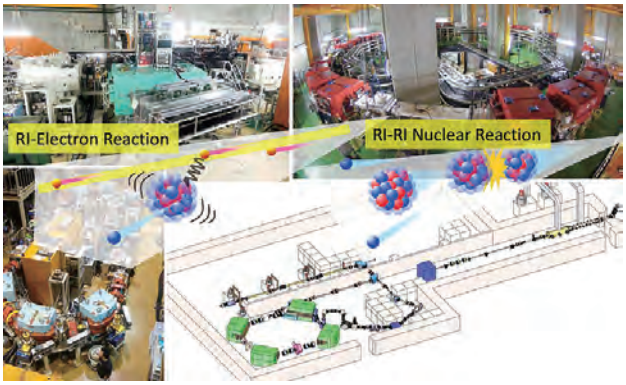
Scope of Research

One of our research is an experimental research for unstable nuclear structures by means of the electron and heavy-ion accelerators. We address the technical development in an RI beam production driven by a high-energy electron beam, an electron scattering from the RI's in combination with the RI target inserted in an electron storage ring, and the precision mass measurement for extremely short-lived and rare exotic nuclei using a heavy-ion storage ring. We will address some technical development aiming at a nuclear photo-absorption cross-section measurement and the beam recycling in a heavy-ion storage ring to study the nuclear reactions involving rare exotic nuclei.



KEYWORDS

Beam Physics
Accelerator Physics
Neutron Optics
Storage Ring
Unstable Nuclear Physics

Selected Publications

Wakasugi, M.; Togasaki, M.; Ohnishi, T.; Kurita, K.; Toba, R.; Watanabe, M.; Yamada, K., FRAC: Fringing-RF-Field-Activated DC-to-Pulse Converter for Low-Energy Ion Beam, *Rev. Sci. Instrum.*, **89,** 095107 (2018).

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Tsukada, K.; Enokizono, A.; Ohnishi, T.; Adachi, K.; Fujita, T.; Hara, M.; Hori, M.; Hori, T.; Ichikawa, S.; Kurita, K.; Matsuda, K.; Suda, T.; Tamae, T.; Togasaki, M.; Wakasugi, M.; Watanabe, M.; Yamada, K., First Elastic Electron Scattering from ^{132}Xe at the SCRIT Facility, *Phys. Rev. Lett.*, **118,** 262501 (2017).

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Launch of KAKEN-RNC Collaboration and Relocation of Heavy-Ion Storage Ring (s-LSR) to RIKEN

We launched KAKEN-RNC collaboration to drive a new research field in unstable nuclear science. One of the attempts in the collaboration is a co-development of a *beam recycling* technique in a heavy-ion storage ring. That aims to a study for nuclear reaction especially for rarely-produced radio-active isotopes (RI) and RI-RI collision experiments not yet realized.

What is a *beam recycling*? In a nuclear reaction study, we observe what happen when a high-energy-nuclear beam hits a thin fixed target. Normally, only a tiny part of the injected nuclei participates in the collision with the target nuclei. Conversely, the most of them are thrown away without any reactions with the target nuclei, because the nuclear reaction cross section is extremely small. In a heavy-ion storage ring in which a high-energy nuclear beam is accumulated, nuclear reactions can be observed when we provide a thin target in the beam-circulation orbit. Unlike a conventional way, the beam passing through the target without any reaction is recirculated in the ring and the accumulated beam hits target turn by turn. It is wonderful that the beam can keep turning around until nuclear reaction takes place. This is a *beam recycling*. The *beam recycling* technique should greatly contribute to an effective use of beam especially for the rarely produced unstable nuclei. We believe that a *beam recycling* technology open up new research area such as an RI-RI collision experiment.

There are some technical challenges to establish the *beam recycling*. We need to compensate turn by turn the energy loss and the emittance growth taken placed at the internal target to keep the steady beam circulation. In KAKEN-RNC collaboration, we will develop jointly the new technology required for *beam recycling*. We are convinced that the heavy-ion cooler storage ring (s-LSR) constructed at KAKEN more than ten years ago is perfectly suitable for the R&D study. Therefore, we disassembled s-LSR and carried them to RIKEN RI Beam Factory (RIBF) in this year (see Figure 1).

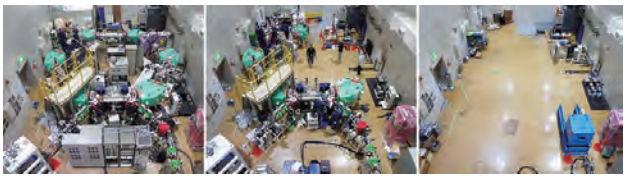

Figure 1. Reassembling of s-LSR at KAKEN accelerator facility.

We are going to reconstruct s-LSR as a new storage ring named RUNBA (Recycled-Unstable-Nuclear Beam Accumulator) at the ISOL (Isotope Separator On-Lin) facility in RIKEN RIBF where low-energy radioactive-isotope (RI) beams are provided for nuclear physics research (see Figure 2). Rough sketch of RUNBA planed at RIKEN RIBF is shown in Figure 2. The RI beam from ISOL will be transported to a charge breeder, which converts the incoming singly-charged ions to highly-charged ions, and fully stripped RI ion beams are injected into RUNBA. The RI ion beam is accelerated up to 10 MeV/u in RUNBA for being ready for nuclear fusion reaction. We plan to accumulated ^{6}He beam produced by ^{7}Li(γ,p) reaction in the day-one experiment. We are now developing infrastructure and working on design study for RUNBA and technical design for the required components in RUNBA.

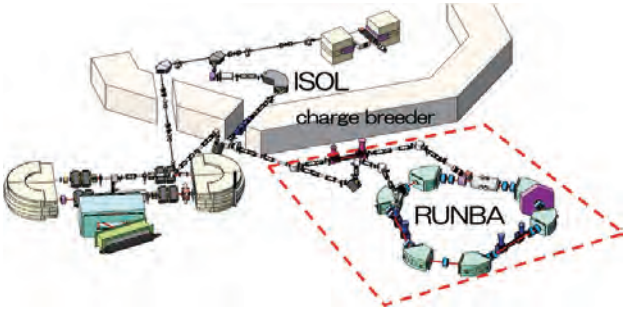

Figure 2. Sketch of RUNBA reconstructed at RIKEN RIBF.